South Wairarapa District Council Application for consents for Featherston Wastewater Treatment Plant Upgrade Discharges

Expert Conferencing

(ground water quality and instream ecology)

Context

1. South Wairarapa District Council (**District Council**) has applied to Greater Wellington Regional Council (**Regional Council**) for consent to authorise the ongoing operation of the Featherston Wastewater Treatment Plan (FWTP).
2. The application has been lodged. There is also further information provided by the Applicant in response to further information requests and two additional Memoranda relating to s107 and s 107D issues. There is also a report prepared by Dr Ausseil of Aquanet dated 8 April 2018. All of this information is available to the experts.
3. A Panel has been appointed to hear the application. The Panel has directed the exchange of evidence and a hearing date.
4. During the preparation of evidence it became apparent to both Councils that further expert discussion and analysis of the potential effects arising from the application would assist both Councils, submitters and ultimately the Panel in making a decision. The Councils have accordingly requested from the Panel an extension to the timeframes directed by the Panel.
5. To ensure that the appropriate information is available to all parties, Council experts will conference.
6. Following conferencing, the experts will produce a draft joint report on these effects. There will then be further discussion and potentially further clarification may be sought from the experts before they finalise their report.
7. It is intended that the final report will become part of the evidence for the hearing panel. However, either expert will be at liberty to subsequently vary their opinion for good reasons.
8. The following questions have been developed to assist the experts with discussing effects and determining the areas of agreement and disagreement.

Key Issues

9. The potential adverse effects which may arise from the proposal, which are the subject of the agreed caucusing include: instream water quality and ecological effects and effects on groundwater quality health risks.
10. At this stage it would be helpful if all potential effects in relation to these two receiving environments, could be identified and "dimensioned".
11. An assessment of what effects may arise, and the likely nature, scale, longevity and importance of those effects will be of assistance to the Council's and the Panel. (The questions of whether effects are more than minor or significant within the context of the application as a whole are for the Panel.)
12. In terms of context, those adverse effects fall for consideration under section 104(1)(a). The adverse effect arising are also relevant to a planning assessment against objective O25 and policy P71 and P81 of the proposed Plan, section 107 and potentially s104D of the Resource Management Act.

13. Whilst it is not for the experts to determine compliance with those provisions, it would be helpful for the experts to familiarise themselves with those provisions, and the factors that they set out for consideration.

QUESTIONS FOR EXPERTS TO CONSIDER
Adverse Effects on Groundwater

a) What are the potential risks associated with groundwater mounding?
b) What is an acceptable (in terms of risk and nature of effect) magnitude, (i.e. water level relative to ground level), duration, and frequency of groundwater mounding both on and off the proposed land application site?
c) Over what land area mightl this mounding occur and how does it alter over different inflow, irrigation and climatic scenarios?
d) What is the likelihood of unacceptable mounding at stage 1b, 2a and 2c.
e) What level of certainty is there around potentially unacceptable mounding at each stage?
f) What additional information is required to address residual uncertainty to an acceptable level, and is it that information obtainable?
g) To what extent can the potential for unacceptable mounding be addressed by discharge management via a management plan or other adaptive management techniques?
h) What effect would the management of discharge to land, to avoid unacceptable discharge effects (i.e. mounding), have on the direct discharge to surface water and/or dam storage i.e. would it result in an increase (as compared to what is proposed at these stages) to direct discharge to the stream (increased rates, volumes or loads) with particular attention to times of below median flow, and/or the required storage volumes?
i) What is an acceptable risk with respect to maximum pathogen magnitude and migration from the proposed discharge. This should include (but not be limited to) development of a suitable 'envelope of effects' with regard to potential pathogen migration and associated mitigation/management measures.
j) What level of assessment is required to provide a sufficient degree of certainty regarding the presence, location, vulnerability, and overall risk to relevant human and environmental receptors? This should include (but not be limited to) the potential presence of water supplies e.g. boreholes on neighbouring properties that are not recorded in the GWRC borehole database; but are still being utilised for Permitted Activity take purposes and in particular domestic supply.
k) Is there further information that is required?
l) What amount of subsurface hydrogeological investigation has been undertaken to assess and characterise the groundwater and soil conditions and how do these vary across the site on a seasonal basis?
m) To the extent that there are any information gaps or uncertainties, can these be addressed via monitoring and adaptive management?

QUESTIONS FOR ECOLOGICAL AND WATER QUALITY EXPERTS TO CONSIDER
Adverse Effects on instream water quality and ecology

The Aquanet Memorandum of 8 April 2018 has identified a number of actual or potential instream adverse effects arising from the discharge. The caucusing should focus on those effects and in particular:

a) What are the particular *water quality* effects of concern and why are those of concern?
Refer to Table below

b) What are the particular actual or potential *ecological* consequences of those water quality changes and are they adverse? (if so why?)
Refer to Table below

c) For each of the effects identified at a and b above, to what extent will those effects be reduced at each stage as compared to the current (existing environment)? (Summarise in Table 1)
Refer to Table below

d) What is the cause of the particular water quality and ecological effects of concern?
Refer to Table below

e) Which are the key contaminants in the discharge causing the effect(s)?
Refer to Table below

f) What options are available to mitigate or avoid the effects in issue (e.g. avoiding discharge at certain flows, further treatment, bringing forward land additional land treatment etc.)?
Options to reduce effects include avoiding discharges to the stream when low dilution (less than 1:15) is available (particularly during stable flow conditions), or improve treatment/removal of contaminants, in particular particulate organic matter and ammoniacal-nitrogen. Riparian planting and preventing direct livestock access along Donald Creek would improve overall ecological health and partially mitigate effects on periphyton and macroinvertebrates.

g) In terms of effects on water clarity, what are the likely ecological impacts of such effects? *Refer to Table below*

What are the water quality/ecological risks and benefits of only operating the discharge at night (during stage 1B) to minimise or avoid "conspicuous" change.

This option might address some visual perception issues but is risky ecologically, as it would increase ammonia concentrations at night (as twice the discharge volume would have to be discharged at night). We do not recommend pursuing this option.

h) To what extent is it likely, that any more than minor adverse ecological effects during stage 1B will be reversed and avoided after the commencement of stage 2A ?
Refer to Table below

i) Outline your respective views on the merits of adaptive management to mitigate any potentially significant adverse effects on aquatic life (particularly at stage 1B)
Adaptive management has value with adequate triggers /controls. Monitoring of ecological effects in spring and autumn will confirm the scale of effects during stage 1B. If significant effects are identified, options such as those discussed in response to question f) above could be explored.

j) What management options are potentially available in terms of adaptive management? (particularly at stage 1B) if the discharge is found (by monitoring) to be causing significant adverse effects on aquatic life/ecology at this stage?
See response to question f) above

k) Are you able to suggest appropriate triggers for adaptive management at stage 1B? (Comment on the approach adopted by the Panel for the Martinborough and Greytown consents in relation to adaptive management.)
It is difficult to define numerical triggers without understanding the context/ framework. If required, numerical triggers can be defined to fit the consent conditions framework.

l) What benefits would bringing forward stages 2A and/or 2B have? (now 10 and 13 years) have.
Stage 2A will result in significant improvement in water quality/reduction of ecological effects. As described in the tables below, recovery/improvement from one stage to the next is expected to be rapid, in the order weeks to months.

m) Are there any additional adverse effects that you consider should be addressed, which have not been addressed above? If so, what are those effects?
We have not dealt with effects on groundwater quality or cultural values as these are outside our field of expertise

Specific questions relating to Aquanet Memo of 8 April 2018

a) In terms of fine *particulate deposition*: What flows/velocities are required to significantly reduce or avoid such deposition?

b) What flows/velocities are required to “flush” such deposited material from the stream bed?

c) In terms of *Dissolved Oxygen*, are the relevant guidelines likely to be met at stage 1B?

d) If not, what are is the likely frequency and duration of likely exceedances?

e) What are the likely ecological impacts/effects if the daily minima is exceeded but daily average DO is kept within acceptable limits?

f) What is the potential to address potential adverse ecological effects arising from DO by way of managing the timing and rate of discharge and the flows at which the discharge occurs?

g) In terms of *Ammonia*, what is the appropriate guideline value for Donald Creek to avoid significant adverse effects on aquatic life after reasonable mixing?

h) Is that guideline likely to be achieved at stage 1B?

i) In terms of *Nutrients:* To what extent will monthly and annual nutrient loadings be reduced at stage 1B from current levels? (consider monthly loads for each calendar month).

j) Will the avoidance of discharges at below median flow from stage 1B result in significant mitigation of the ecological effects arising from current nutrient discharges?

k) What further information is required to answer this question?

l) Is this still considered to be useful and will a survey in October/November be sufficient?

m) Please comment on the above within the context of the proposed Stage 1B discharge regime.

n) Please correct the assessment against P7 by reference to the recent Mott McDonald Memorandum. (29 days per year on average of discharge at flows below median).

o) Is 33% change in clarity a useful proxy/guideline in relation to the deposition issue which is raised in the Memo or would some other measure be more appropriate in relation the deposition and associated ecological effects?

p) What evidence/data supports these statements specific to Donald Creek? Is more hydrological information required?

q) In terms of stage 1B: What is the frequency and duration of such overly stable periods coinciding with flows above median flow (when discharge occurs)?

r) To what extent is this flow stability caused by upstream water takes?

s) Is there potential to flush the affected areas of stream bed by providing additional stream flow on a regular basis?

(If so, how much additional discharge volume or stream flow would be required and how often?)

t) During stable flow periods would there be benefits from concentrating discharges over a particular period of the day (say at night) and ceasing discharge for a period of time each day? (ie would this reduce deposition and/or allow for some degree of flushing?)

u) Do the experts agree that in this context, measurable equates to more than minor adverse effects?

v) Do the experts agree that 20% change to QMCI is a useful measure of adverse effects?

w) Do they consider that the duration and reversibility of such changes is also relevant?

x) What is the *likely* level of effects (high moderate or low) on aquatic life during the spring autumn period at stage 1B?

y) What are the specific effects (eg what species are likely to be affected and how) and how long will such effects endure after the discharge ceases or flow increases?

z) What further information is required to answer this question?

aa) If consent is granted, what post consent monitoring is required to address the uncertainty?

bb) What would be an appropriate monitoring regime and trigger for further investigations or action? (please answer by reference to the approach which was adopted in relation to the Greytown consent where there were potential QMCI issues.)

These questions relating to the 8 April memo have been substantially addressed in the tables below

Ecological and water quality effects

Table 1 Summary of expected water quality and ecological effects during each proposed stage

Effect	**Existing and 1A**	**1B**	**2A**	**2B**
Visual Clarity	>33% clarity reduction most (ca. 67%) of the time. Often >50% clarity reduction.	>33% clarity reduction 21% of time (75 days per year).	>33% clarity reduction 11% of time (42 days per year)	Less than minor/rare (2 days per year)
Visual Clarity for purpose of Policy 71, i.e. no more than 33% reduction in visual clarity when stream is at < median flow	Exceeded up to 179 days per year on average (49% of the time)	Exceeded up to 29 days per year on average (8% of the time)	Exceeded up to 15 days per year on average (4% of the time)	No exceedance due to almost no discharges at <median flow at Stage 2B
	The above numbers are from Mott McDonald memo dated 7 August 2018. We consider these estimates to be conservative because they assume 100% exceedance of the P71 standard when a discharge to the stream occurs at flows < median. Further analyse may allow for less conservative estimates.			
Deposition of particulate organic matter on stream bed	Common in summer low flow	Possible during autumn depending on flow conditions. Magnitude less than in summer currently and duration typically 2-3 weeks	Unlikely due to flow conditions when discharges occur.	None expected
Dissolved oxygen	Some degree of detrimental effect on diurnal minimum DO concentration/saturation is expected, but data too limited to quantify	Negligible to small effect due to reduced discharge volume during summer low flow periods. Some effect possible in Autumn if long period of stable/low flows	Negligible to small effect due to reduced discharge volume during summer low flow periods.	Negligible effect
Ammonia	Chronic toxic effects are expected on a range of aquatic life	Low risk of effects on most species, but possible chronic effect on most sensitive species i.e. FW	Low risk of effects on most species, but possible chronic effect on most sensitive species i.e. FW	Negligible effect

			clam and kākahi (if present).	clam and kākahi (if present).	
Periphyton growth		Stimulation of periphyton growth downstream during spring, summer and autumn. Likely to exceed Obj 25 “significant” threshold (50mg/m^2) Likely to occasionally exceed Obj 25 “default” threshold (120 mg/m^2).	More than minor in spring/Autumn for limited periods of time (duration depends on hydrology) Likely minor in winter Minor in summer	Minor or less. Occasional stimulation of periphyton growth in spring/autumn but for short duration	Negligible
Macroinvertebrate communities	(Spring)	More than minor, probably not significant adverse effects	More than minor but not “significant adverse” for limited periods of time (2-3 weeks)	Possibly more than minor for limited periods of time (2-3 weeks)	Negligible
	Summer	Significant adverse effects	Negligible	Negligible	Negligible
	Autumn	Significant adverse effects	More than minor, possibly significant for limited periods of time (2-3 weeks)	More than minor but not “significant adverse” for limited periods of time (2-3 weeks)	Negligible
	Winter	Generally minor, occasionally more than minor	Generally minor, occasionally more than minor	Generally minor, occasionally more than minor	Negligible
What else?		TN/TP loads not specifically considered as part of this exercise – refer to AEE. Our assessment assumes negligible inputs of contaminants (nutrients) from the land irrigation area to the stream, directly or indirectly via groundwater. Assessment of existing situation/Stage 1A was conducted on the basis of available data Assessment of future stages (1B, 2A and 2B) was conducted on the basis of modelling outputs provided to us (discharge quality, quantity and timing, synthetic stream flow and predicted in-stream concentrations). Our assessment is subject to change should any of these modelling outputs change.			

Table 2 Characterising the effects at each stage

A Issues common to all stages		
Question/issue	**Responses**	**comments**
Nature, characteristics and sensitivity of the receiving/affected environments (including downstream receiving environments)	Otauira Stream (also called Abbott Creek) and its tributaries (including Donald Creek) are Class 5. Table 3.4 Objective 25 classifies the Otauira Stream and all its tributaries as "Significant River". We note that the map only shows the reach of Otauira Stream upstream of the Donald Creek confluence as Significant River. This ambiguity needs to clarified. If Donald Creek is classified as "Significant River", the following Objectives apply: • MCI Objective is 120 • Periphyton objective is 50 mg/m^2 (17% exceedance) If Donald Creek is not classified as "Significant River", the following Objectives apply • MCI Objective is 100 • Periphyton objective is 120 mg/m^2 (17% exceedance) Macroinvertebrates upstream of the discharge Upstream of the discharge, MCI ranged 69-93 in summer and 87-98 in Spring, 91-92 in Autumn MCI scores are generally indicative of Fair water quality Objective 25 MCI score is not met upstream regardless of Significant/not Significant classification Periphyton upstream of the discharge Chlorophyll-a 4-14 mg/m^2 in October 41-48 mg/m^2 in November upstream of the discharge. Data is too limited to assess whether "Significant River" Objective 25 (50mg/m^2) periphyton biomass is met upstream. The 120	

	mg/m^2 objective is likely to be met upstream of the discharge (noting that up to 17% exceedances are allowable). Hydrology: Donald Creek flow is highly seasonal with a high winter baseflow compared to summer. Freshes/flushing flows are much more frequent in the period May to October than the rest of the year Substrate: Primarily hard bottom, but observed to have a reasonably mobile sand/silt component when flow about median flow Macrophyte are quite common (typical spring fed stream) Upstream water quality SIN usually elevated enough to not be limiting periphyton growth upstream. DRP upstream is generally moderate and sufficiently low to exert mild/moderate limitation of periphyton growth at times. Ammoniacal-N concentrations are consistently very low (Median and 95th percentile concentrations within NPSFM Band A/ 99% protection level) Downstream of the discharge, increases in both SIN (predominantly as ammoniacal N) and DRP concentrations. There is likely no or very minor nutrient limitation of periphyton downstream of the discharge due to the removal/suppression of DRP limitation. Otauira Stream (Abbott Creek) has large gravel substrate. The section above Donald Creek confluence is often dry during summer. **Lake Wairarapa** Lake Wairarapa is supertrophic and does not meet national bottom line for nutrients/algae. There is a long-term improving trend in the lake's water quality due to reducing phosphorus concentrations.	

	The discharge is a minor contributor to total nutrient loads to the lake, and reducing discharge loads will incrementally contribute to improved lake water quality.	

Nature and significance of aquatic species / communities present in the receiving environment.	Donald Creek and Otauira Stream support populations of large longfin eel (at-risk declining status) and common bully. Rainbow trout and inanga have also been caught in the streams. Good habitat is provided for fish where the stream passes through the bush remnant by riparian cover, and woody debris in the stream creating a diversity of hydraulic regimes. *Ammonia toxicity* NIWA memo prepared by Dr Chris Hickey (28 Sept 2018) – key points: We agree that using 95% protection level ('default' protection level in ANZECC guidelines for "slightly disturbed ecosystems" corresponding to NPSFM Band B) is sensible for Donald Creek. This corresponds to in-stream total ammoniacal nitrogen concentrations of less than: • 0.24 mg/L as an annual median • 0.40 mg/l as annual maximum (agree to compare to 95th percentile of measured or modelled data, consistent with (Hickey 2014[1])) The above numbers assume pH = 8, which is a reasonable, albeit relatively conservative, representation of pH conditions in Donald Creek (based on limited data). This level of protection will provide long-term (chronic) protection for the range of species identified in Donald Creek, including *Sphaerium sp.* (fingernail clam). However, these numbers would likely be only partially protective of chronic effects on Kākahi (freshwater mussel), and there would be reduced survival in a population at these concentrations A 95th percentile concentration not exceeding 0.24 mg/l would be required to be fully protective of kākahi.	

[1] Derivation of indicative ammoniacal nitrogen guidelines for the National Objectives Framework. NIWA memo dated 7 March 2014.

	• The 90% species protection level is: 0.54 mg/L as an annual median • 0.92 mg/l as annual maximum (we agree to compare to 95th percentile of measured or modelled data, consistent with Hickey 2014) Long term exposure at this protection level corresponds to up to 20% reduction in adult fingernail clam survival attributable to ammoniacal N. 80% species protection level is the NPSFM bottom line: • 1.30 mg/L as an annual median • 2.20 mg/L as annual maximum (we agree to compare to 95th percentile of measured or modelled data, consistent with Hickey 2014) Long term exposure at this protection level corresponds to 20% to 50% reduction in adult sphaerid survival attributable to ammoniacal N	
Existing Environment and Stage 1A		
Question/issue	**Responses**	**comments**
Nature of the effect (s) (eg, effects on particular species)	<u>**Summer/ Autumn**</u>: <u>Macroinvertebrate and periphyton</u> Summer/autumn low flows: Major decline in aquatic invertebrate health (consistent decline over all indices). Indications of small amount of heterotrophic growth in summer low flow and increased periphyton downstream of the discharge. Effects will be dependent on the stream’s flow regime, for example the survey in April 2018 found little or no difference in periphyton biomass or macroinvertebrates, noting that the survey was conducted shortly after a flood.	

	Dissolved Oxygen Given the significant deposition of organic matter, elevated periphyton biomass and presence of sewage fungus, some degree of detrimental effect on diurnal minimum DO concentration/saturation DO is expected. However, the data is too limited to quantify this effect. **Overall conclusion (Summer/Autumn)**: High magnitude of effects, consistently for long periods of time during summer – equates to significant adverse effects on aquatic life and does not meet S107(1)(g). We expect these effects to be prevalent in December to March inclusive. They may extend further in April/May in some years, depending on hydrology. Effects will perdure until first autumn flushing flows. Key contaminants/likely causes: • Smothering of stream bed by particulate organic matter • Ammonia concentrations sufficiently high to cause chronic toxic effects on aquatic life • Stimulation of periphyton growth by nutrients (N and P) in the discharge No further downstream surveys were undertaken during summer – so we have no reliable indication of the downstream spatial extent of effects. **Spring (Sept- Nov)** The November 2016 survey a good representation of current spring effects. November 2016 survey:	

	• Decline in QMCI (nominally more than 20% reduction) but only small reductions in other indices at first downstream site. Effects less apparent at second downstream site; • Increase in periphyton chlorophyll-a (119 mg/m^2), in excess of OBJ 25 threshold (50 mg/m^2), but within recreational guidelines (120 mg/m^2 for filamentous algae). Little change in biomass as measured by AFDM and all sites well within recreational guidelines (30 g/m^2). Effects on macroinvertebrate and periphyton/aquatic life in spring are expected to be more than minor (detectable and of ecological relevance), but probably not over a "significant adverse" threshold. The best way to improve certainty about these effects is via monitoring. ***Ammonia (year-round)*** The discharge causes substantial increases in ammoniacal-N concentrations. Currently, downstream of the discharge (Table 36, Mott WQ report), total ammoniacal-N concentrations are as follows: • Measured median concentration of 0.44 mg/L – (in 90% protection, Band C) • Measured 95th percentile of 1.7 mg/L (higher than 90% protection level, but in 80% / NPSFM Band C) Chronic toxic effects are expected on a range of aquatic life under the current situation. ***Visual clarity (year-round)*** A 33% change in visual clarity is a commonly used numerical threshold for conspicuous changes in water clarity. It is based on panel studies, and is in national guidelines. Visual clarity changes of no more than 30% to 35% are used as targets/ limits/ standards in a number of regional plans as numerical translation of 107(1)(d) (e.g. Tukituki Plan Change 6, Horizons One Plan, Canterbury Regional Plan).	

	We note that the conspicuousness of a visual clarity change can be influenced by a range of physical factors, such as light conditions, water depth, velocity, background water clarity. The discharge currently causes greater than 33% reductions in clarity about 2/3 of the time. These reductions would be conspicuous to an observer (if any) as a green "cloudiness" downstream of discharge, noting however that reductions in clarity are less conspicuous in shallow stream reaches. Reductions over 50% are currently a common occurrence. These are expected to be very conspicuous and associated with colour change. Visual clarity changes in Donald Creek are caused by particulate organic matter in suspension in the discharge (e.g. algae, cyanobacteria and bacterial matter). Visual clarity changes in Donald Creek are unlikely to cause direct significant ecological such as reduction in euphotic depth or reduction in fish feeding ability (native fish are generally not considered sight feeders). The key associated ecological effect is caused by the deposition of particulate organic matter on stream bed, which is a known mechanism of detrimental effect on macroinvertebrate communities. Substantial organic matter deposition was observed in summer (Coffey reports), but not during the spring or autumn surveys.	
Caused by discharges at what flows?	The response varies depending on the contaminant/effect considered. The key contaminants of concern with regards to effects are - Particulate organic matter in relation to effects on visual clarity and macroinvertebrates (via deposition) - Ammoniacal-N in relation to toxic effects on aquatic life - Nutrients (nitrogen and phosphorus), in relation to periphyton growth	

	Effects on visual clarity seem to occur year round, although the risk decreases with dilution rate in the stream. The risk of exceeding 33% clarity change is: - High when dilution is less than 1:10 - Moderate (60% risk of exceedance) when dilution is 1:10 to 1:15 - Low when dilution is greater than 1:15, especially during winter, although we can't exclude occasional exceedances (data limitation data prevents an accurate quantification). Toxic effects of ammonia can occur year-round, with a higher risk of effects at lower dilution/stream flows. The risk of effect is not mitigated by flushing flows beyond the higher dilution rates. Effects associated with the deposition of organic matter and nutrients (via periphyton growth) will take time to develop after a flushing flow – typically 2-3 weeks of stable flow conditions.	
Degree/intensity of effect	Macroinvertebrate community: High magnitude of ecological effect during summer/autumn until autumn floods and increase in baseflow. More than minor, but probably not "significant adverse" effects during winter/spring. Chronic ammonia toxic effects (reduced survival) are expected on a range of aquatic life. Water clarity: Clarity changes over 33% occur about 2/3 of the time. Very conspicuous reductions in visual clarity (over 50% reduction) and colour occur about 45% of the time Major (over 70%) reductions in visual clarity occur 22% of the time	

Areal Extent	Macroinvertebrate, ammonia and visual clarity effects are expected to extend to the length of Donald Creek downstream of the discharge and some likely influence on Otauira Stream We note that the Longwood water race also contributes contaminants which make distinguishing effects more difficult from ca. 600m downstream of the discharge	
Frequency	Near continuous, but worse during summer/ autumn low flow period.	
Duration	All year, much worse in summer	
Endurance/reversibility after flushing event and/or cessation of discharge	All effects are fully reversible after full cessation of the discharge. Macroinvertebrate communities are expected to recover to upstream levels within weeks after cessation of the discharge. Effects on water clarity only occur when the discharge is operating, so will cease immediately after cessation of discharge. The only exception may be that populations of sensitive species such as kākahi may take a long time to re-establish naturally, or may not re-establish at all due to other influences. Effects on visual clarity and toxic effects on ammonia may re-start immediately after a high flow event (essentially as soon as dilution rates are low enough and upstream water clears up after a fresh/flood) Effects associated with the deposition of organic matter and nutrients (via periphyton growth) will take time to develop after a flushing flow – typically 2-3 weeks of stable flow conditions.	
Endurance/reversibility of the effects: After the discharge ceases for period or after flushing event	See above	

Endurance into the next season and year	See above	
Endurance once the next stage is established	Effects will quickly "stabilise" to the level/frequency corresponding to each stage following implementation of each stage. Reduction in discharge and total ammonia concentration downstream will increase the possibility for kākahi colonisation of Donald Creek. However, when or if this occurs is highly uncertain.	
Overall ecological importance/significance of the effects during stage 1A having regard to the factors above	Overall, the current discharge has substantial effects on the aquatic macroinvertebrate community during summer. There is substantial recovery during the higher river flows in winter/spring but more than minor effects are still evident. Effects on visual clarity are often significant, major at times.	

<table>
<tr><th>Stage 1B</th><th></th><th></th></tr>
<tr><th>Question/issue</th><th>Responses</th><th>comments</th></tr>
<tr><td>Nature of the effect (s) and reasons why adverse</td><td>In order to answer these questions, we analysed stream flow data against predicted discharge regime, with particular regards to:
• Stream flushing flows,
• Dilution rates
• When the discharge to the stream starts and stops seasonally
Generally, there is a high frequency of flushing flows in June to September, with a flow recession period starting in late September/October/early November, depending on the year.
Typically, the discharge during Stage 1B is predicted to operate full time from June to August, and to carry on to a mid-point in the spring flow recession period (typically when stream flows drop to or below median flow).

Due to its timing in relation to stream flows, the November 2016 survey provides a good representation of likely spring effects during stage 1B.
November 2016 survey:
• Decline in QMCI (nominally more than 20% reduction) but only small reductions in other indices at first downstream site. Effects less apparent at second downstream site;
• Increase in periphyton biomass (119 mg/m^2), in excess of OBJ 25 threshold (50 mg/m^2), but within recreational guidelines (120 mg/m^2)
On that basis, effects on macroinvertebrate and periphyton/aquatic life in spring are expected to be more than minor (detectable and of ecological relevance), but probably not over a “significant adverse” threshold.
The only way to address this uncertainty is via monitoring during Stage 1B.

In summer (November to March), there will be no or very little discharge, the only predicted discharge events are of short duration and we expect the effects of the discharge on stream water quality/ecology to be no more than minor.</td><td>It would be useful to extend the synthetic flow record and modelled discharge regime to cover the period ending May 2018 to coincide with time when autumn and spring ecological surveys were undertaken (the same would apply to any new survey).

Limited data available suggest synthetic flow record may underestimate dilution available during winter and spring compared to actual flow records.</td></tr>
</table>

	Autumn (April/May/early June) We identify this period as presenting a higher risk of effects than during spring, particularly when discharges to the stream re-start but stream flows remain relatively low. Observation of flow and predicted discharge indicate this typically occurs for a period of 3-5 weeks each year, noting however that discharge volumes are typically lower and dilution rates higher than currently. Ecological effects of the discharge will increase during that period until the next flushing flow. Currently, effects during summer are significant and remain significant in autumn until the first flushing flow. In stage 1B, the summer effects will be no more than minor (no or little discharge), and effects from the Stage 1B discharge will take 2-3 weeks to build up and are less likely to be significant and will be of shorter duration/frequency compared with currently. The scale of effects during autumn will be less than during summer currently but likely worse than during spring. The autumn effects are expected to be more than minor, but of relatively short duration. Whether the magnitude is "significant adverse" for short periods of time is uncertain and can only be confirmed by monitoring. Relatively high variability in duration and magnitude of effects between years is expected due to the variability in the timing of climatic events (in particular when the discharge re-starts in relation to the first autumn/winter flushing flow). Winter (mid June- mid Sept) is expected to present a lower risk for effects on periphyton growth and macroinvertebrates due to higher base flows and higher frequency of flushing flows and cooler water temperature on	

	most years. Effects during a particularly stable/dry winter (e.g. 2007) are expected to be similar to effects during a typical spring (i.e. more than minor, but probably not “significant adverse”). **<u>Ammonia Toxicity risk</u>** When it occurs, the discharge is predicted to cause substantial increases in ammoniacal-N concentrations. Predicted ammoniacal nitrogen concentrations downstream of the discharge (Table 36, Mott WQ report) - Median concentration of 0.29 mg/L – (just above the Band B/Band C threshold, 95%- 90% protection) - Measured 95th percentile of 0.88 mg/L (within 90% protection level, NPSFM Band C) Predicted summer concentrations are well within Band B/ 95% Protection species, meaning low risk of effects even on sensitive species during summer. In winter, lesser degree and risk of effect compared with current/ stage 1A, but we cannot exclude risk of chronic effect on sensitive species such as freshwater clams and mussels. The above comments re. risk of effects in winter are conservative because they assume pH=8 in the receiving environment. Further examination of winter pH conditions and data analysis would be useful in better characterising the risk of effect. **<u>Water Clarity</u>** The risk of exceeding 33% clarity change is estimated as follows: • High when dilution is less than 1:10 • Moderate (60% risk of exceedance) when dilution is 1:10 to 1:15 • Low when dilution is greater than 1:15, especially during winter. Occasional exceedances cannot be excluded, but limited data prevents an accurate quantification.	

	The original estimate [email from Emma Hammond, dated 30/11/2017] was 34% (125 days per year on average) of time exceeding the 33% clarity change threshold. This was based on assumption that there was a 67% risk of exceeding the clarity change threshold on any day the discharge is operating regardless of season or stream flow. This is considered an environmentally conservative assumption, as it ignores that the discharge will preferentially be removed during times of high risk of effect (i.e. low stream flows/ low dilution). Further examination of the data indicates that, on less conservative assumptions, the exceedance is likely to be closer to 21% (75 days per year on average) (assumptions: 100% non-compliance at dilution<1:10; 60% non-compliance at dilution 1: to 1:15 and 16.7% non-compliance at dilution> 1:15).	
Caused by discharges at what flows?	At Stage 1B, discharges are rare during periods of low flow. The model indicates times of low dilution at higher river low (> median). Some more than minor effects on periphyton and macroinvertebrates are expected in spring (but probably not “significant adverse”). The key period of risk of effects on periphyton and macroinvertebrates is expected to be in autumn when partial discharges occur but river baseflow is still relatively low. Peak ammonia concentrations, caused by discharges when little dilution is available in the stream are still expected to pose a toxicity risk to sensitive species. Effects on visual clarity are expected when dilution rates are less than 1:15	
Degree/intensity of effect	Winter/spring = slightly better than current effects in spring (more than minor, but probably not “significant adverse”). Summer = little if any observed effects due to limited discharge (no more than minor). Autumn = short duration of moderate effects likely (more than minor, possibly “significant adverse”).	
Areal Extent	Full extent of Donald Creek likely	

Frequency	Infrequent. Extent of autumn effect on macroinvertebrates and periphyton is dependent on rain / flow patterns. Effects on visual clarity expected about 20% of the time	
Duration	Autumn effects might typically be apparent for two to three weeks. Duration of effects on visual clarity will depend on discharge regime and dilution available	
Endurance/reversibility after flushing event and/or cessation of discharge	Recovery after flood events expected. Refer to comments in relation to Stage 1A	
Endurance/reversibility of the effects: After the discharge ceases for period or after flushing event	Refer to comments in relation to Stage 1A	
Endurance into the next season and year	Refer to comments in relation to Stage 1A	
Endurance once the next stage is established	Refer to comments in relation to Stage 1A	
Overall ecological importance/significance of the effects during stage 1B having regard to the factors above	Overall, Expect ecological effects to be significantly reduced compared to current situation, both in terms of intensity and duration; - In summer (November to March), there will be little discharge and effects will be no more than minor. - The rest of the year effects are expected to be more than minor for limited periods of time, mostly in autumn, but also possibly spring. Whether they are “significant adverse” for short periods of time is uncertain;	

	- More than minor effects relate to periphyton, ammonia sensitive macroinvertebrate species such as freshwater clams and kākahi (if present; re-establishment may be inhibited if not present)	
Likelihood of the effects occurring	Severity and duration of effects will be subject to the hydrological regime during shoulder seasons and winter. Periods with stable stream flows (no flushing flows) will be more sensitive to effects of the discharge.	
Uncertainties/comments	Our analysis is based on modelled scenarios (synthetic flows, modelled discharge quality and timing) provided to us. Our conclusions are subject to any changes to these modelled scenarios and their outputs.	

<table>
<tr><td>Existing Environment and Stage 2A</td><td></td><td></td></tr>
<tr><td>Question/issue</td><td>Responses</td><td>comments</td></tr>
<tr><td>Nature of the effect (s) and reasons why adverse</td><td>Discharge regime:
Generally, the timing of discharges to the stream is similar to that under stage 1B, but the amount of treated wastewater discharged on any one day is less than under 1B (i.e. greater dilution). The number of days with discharge to the stream is reduced compared with Stage 1B.

<u>Macroinvertebrates and periphyton</u>
Effects on macroinvertebrates and periphyton are expected to be as follows:
- Spring: Possibly more than minor for limited periods of time (2-3 weeks)
- Summer: Negligible
- Autumn: More than minor but not “significant adverse” for limited periods of time (2-3 weeks)
- Winter: Generally minor, occasionally more than minor

<u>Ammonia Toxicity risk</u>
(Note that Table 36 in Mott’s report relates to Stage 2A, not 2A1)
When it occurs, the discharge is predicted to cause substantial increases in ammoniacal-N concentrations.
Predicted ammoniacal nitrogen concentrations downstream of the discharge (Table 36, Mott WQ report)
- Median concentration of 0.24 mg/L – (on the Band B/Band C threshold, 95%- 90% protection)
- 95th percentile of 0.73 mg/L (within 90% protection level, NPSFM Band C)
Predicted summer concentrations are well within Band B/ 95% Protection species, meaning low risk of effects even on sensitive species.</td><td></td></tr>
</table>

	In winter, lesser degree and risk of effect compared with current/ stage 1A, but we cannot exclude the risk of chronic effect on sensitive species such as freshwater clams and mussels. The above comments re. risk of effects in winter are conservative because they assume pH=8 in the receiving environment. Further examination of winter pH conditions and data analysis would be useful in better characterising the risk of effect. **<u>Water Clarity</u>** Risk of exceeding 33% clarity change - High when dilution is less than 1:10 - Moderate (60% risk of exceedance) when dilution is 1:10 to 1:15 - Low when dilution is greater than 1:15, especially during winter. Can’t exclude occasional exceedances but data limitation prevent accurate quantification Original estimate [email from Emma Hammond, dated 30/11/2017] was 27% (98 days per year on average) of time exceeding the 33% clarity change threshold. This was based on assumption that there was a 67% risk of exceeding the clarity change threshold on any day the discharge is operating regardless of season or stream flow. This is considered an environmentally conservative assumption, as it ignores that the discharge will preferentially be removed during times of high risk of effect (i.e. low stream flows/ low dilution). Further examination of the data indicates that, on less conservative assumptions, the exceedance is likely to be closer to 11% (42 days per year on average) (assumptions: 100% non-compliance at dilution<1:10; 60% non-compliance at dilution 1: to 1:15 and 16.7% non-compliance at dilution> 1:15).	

Caused by discharges at what flows?	At Stage 2A, discharges are very rare during periods of low flow. The model indicates occasional times of low dilution at higher river low (> median). The predicted reductions in I&I reduce times of low dilution associated with short rain events.	
Degree/intensity of effect	As above	
Areal Extent	Full extent of Donald Creek	
Frequency	Infrequent. Extent of autumn effect dependent on rain / flow patterns.	
Duration	Autumn effects might typically be apparent for two to three weeks.	
Endurance/reversibility after flushing event and	Reversible	
Endurance/reversibility from year to year and into the next stage	Reversible	
Overall ecological significance during stage 2A having regard to the factors above.	Overall the effects on stream ecology after implementation of Stage 2A are expected to be minor, but we cannot exclude the risk of short term (2-3 weeks) more than minor effects on macroinvertebrate communities and seasonal chronic effect on sensitive species such as freshwater clams and mussels (if present).	
Likelihood of the effect occurring		
Uncertainties/comments	As above in Stage 1B, noting that Stage 2A include additional uncertainty about the extent of I&I mitigation	

Stage 2B		
Question/issue	**Responses**	**comments**
Nature of the effect (s) and reasons why adverse	**<u>Ammonia Toxicity risk</u>** Predicted ammoniacal nitrogen concentrations downstream of the discharge (Table 36, Mott WQ report) - Median concentration of 0.04 mg/L – (well within Band B / 95%-protection) - 95th percentile of 0.14 mg/L (well within Band B / 95%- protection) meaning low risk of effects even on sensitive species. **<u>Macroinvertebrates and periphyton</u>** We expect effects on macroinvertebrates and periphyton to be negligible during stage 2B **<u>Water Clarity</u>** Risk of exceeding 33% clarity change - High when dilution is less than 1:10 - Moderate (60% risk of exceedance) when dilution is 1:10 to 1:15 - Low when dilution is greater than 1:15, especially during winter. Can't exclude occasional exceedances but limited data prevents accurate quantification. Original estimate [email from Emma Hammond, dated 30/11/2017] was 2% (9 days per year on average) of time exceeding the 33% clarity change threshold. This was based on assumption that there was a 67% risk of exceeding the clarity change threshold on any day the discharge is operating regardless of season or stream flow. This is considered an environmentally conservative assumption, as it ignores that the discharge will preferentially be removed during times of high risk of effect (i.e. low stream flows/ low dilution).	

	Further examination of the data indicates that, on less conservative assumptions, the exceedance is likely to be closer to 0.6% (2 days per year on average) (assumptions: 100% non-compliance at dilution<1:10; 60% non-compliance at dilution 1: to 1:15 and 16.7% non-compliance at dilution> 1:15).	
Caused by discharges at what flows?	Almost no discharge from November to May. Discharges during winter will substantially reduce so that they occur only 8% of the time and always when there more than 20 times hydraulic dilution available. Most of discharges that do occur will be during flood events.	
Degree/intensity of effect	Negligible	
Areal Extent	When discharges occur, changes in water quality will still be detectable along the length of Donald Creek, but with negligible ecological effects.	
Frequency	Very infrequent.	
Duration	Short term due to discharges mostly being associated with high river flows.	
Endurance/reversibility after flushing event	Reversible	
Endurance/reversibility from year to year and into the next stage	Reversible	
Overall ecological importance/significance of the effects during stage 1B having regard to the factors above	Overall, we expect the effects on ecological, recreational values and downstream receiving environments to be no more than minor.	

Likelihood of the effect occurring		
Uncertainties/comments	As above for Stage 1B	

Signed by	Date	
Keith Hamill	01/11/2018	
Olivier Ausseil	01/11/2018	